

AI-Powered USB Handbook

USB

AI-Powered USB Handbook Team

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1. AI-Powered USB Handbook

AI-Powered USB Handbook

AI-Powered USB Handbook	USB	USB 3.2 Gen 2x2	Thunderbolt 4 (4)
Type-C			

1.1

- -
- **USB** - USB
- **USB** -
- **Thunderbolt** -
- - USB PD
- -

1.2

-
-
-
-

2. 1 (Introduction)

2.1

USB (Universal Serial Bus) Type-C

USB

USB 3.2 Gen 2x2

AI-Powered USB Handbook

USB

AI

2.2

- 4 USB4
 - USB

2.3

- 1.
 2. USB 1.0 USB4
 3. Intel Thunderbolt USB
 4. USB PD PPS
 - 5.

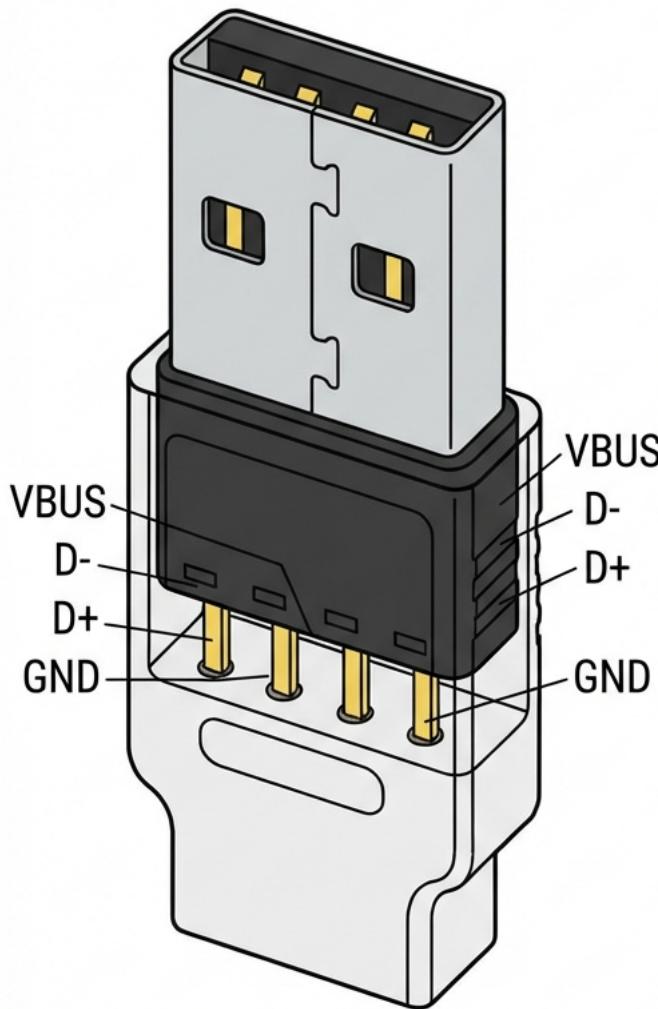
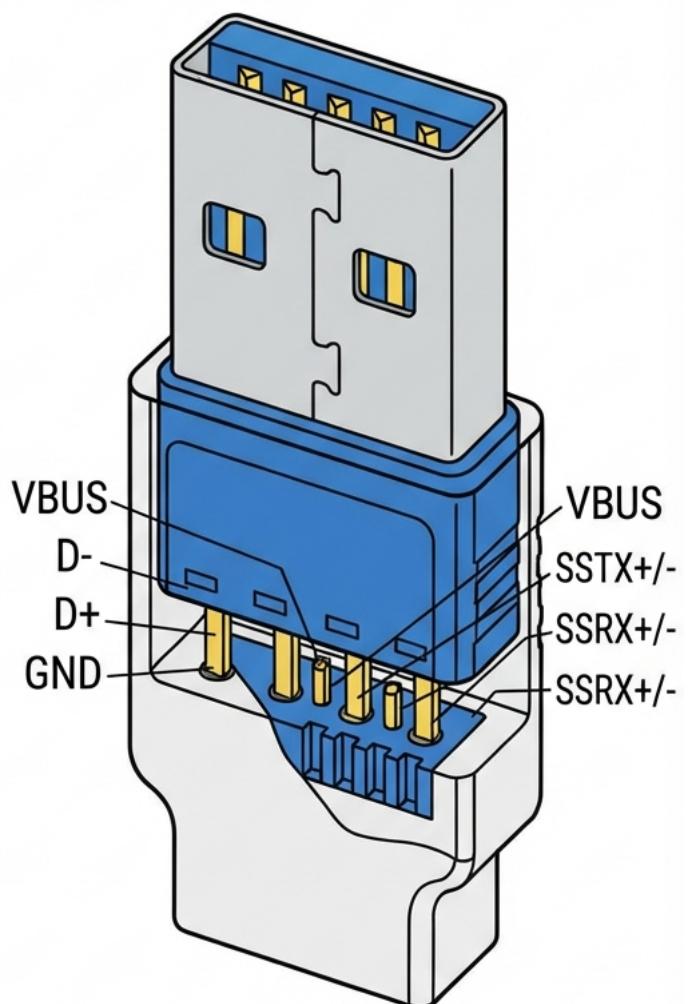
3. 2 USB (USB Connector Types)

USB

3.1 USB Type-A

USB

-
-
- **USB 2.0** 4
- **USB 3.0+** 5 9

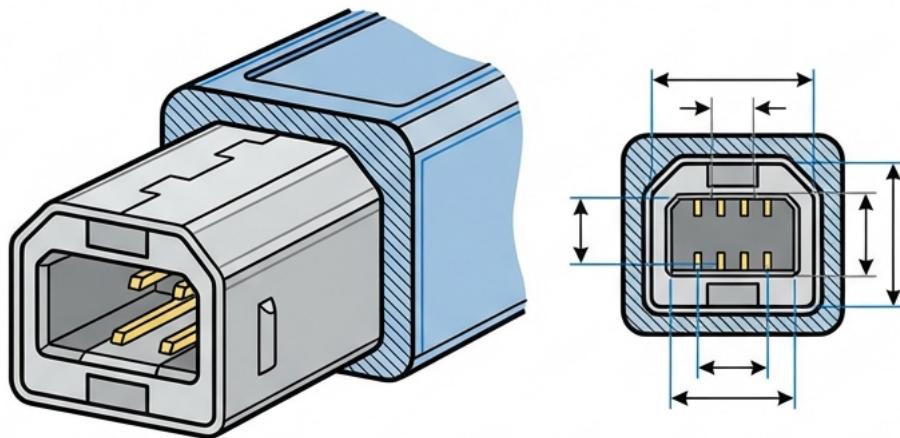
USB 2.0 Type-A**USB 3.0 Type-A (SuperSpeed)****USB 2.0 Type-A****USB 3.0 Type-A (SuperSpeed)**

3.2 USB Type-B

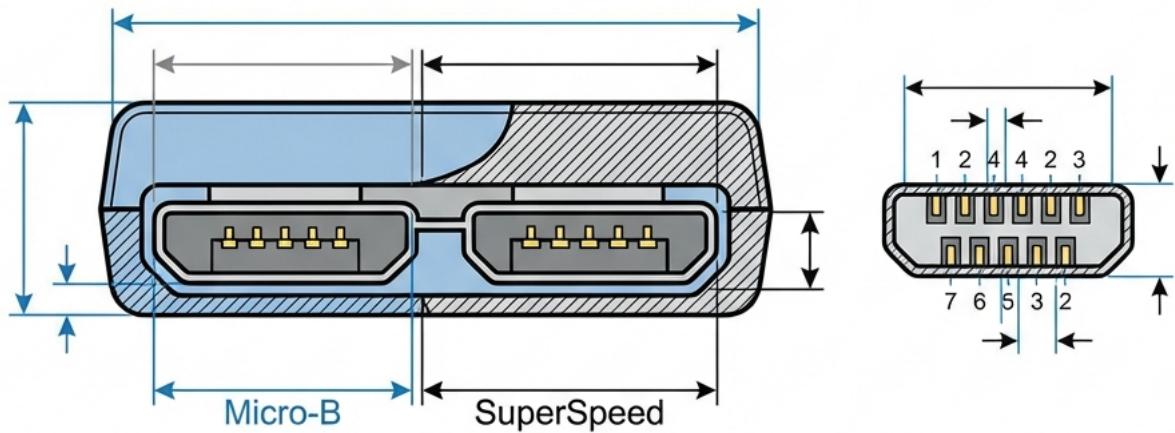
- Standard-B
- Micro-B (USB 3.0)

Elements

USB 3.0



**USB Standard-B
(Printer)**

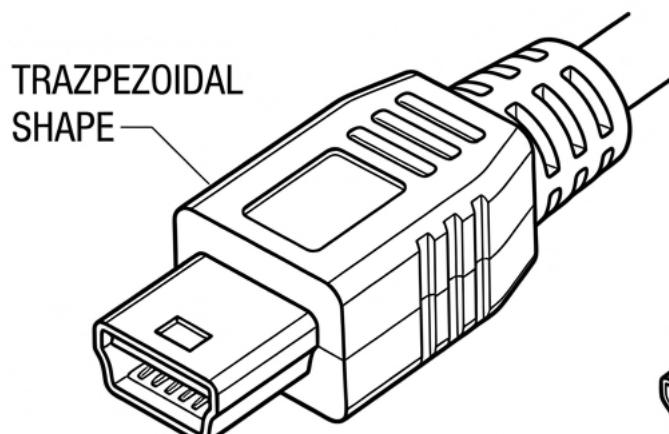


**USB Micro-B SuperSpeed
(External HDD)**

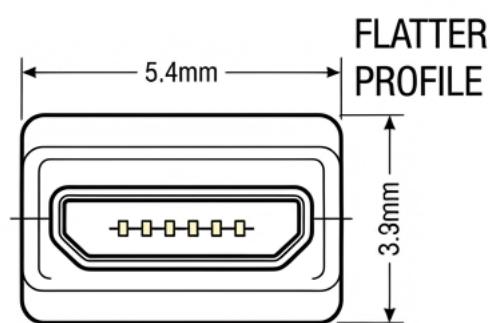
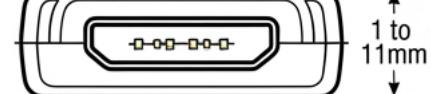
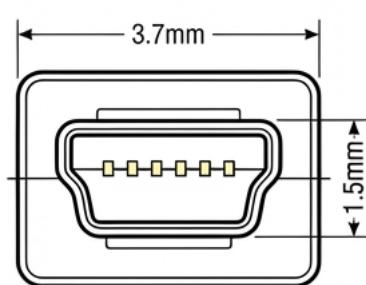
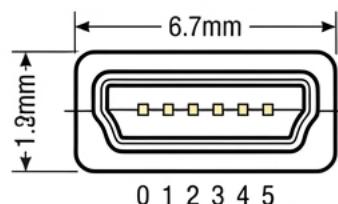
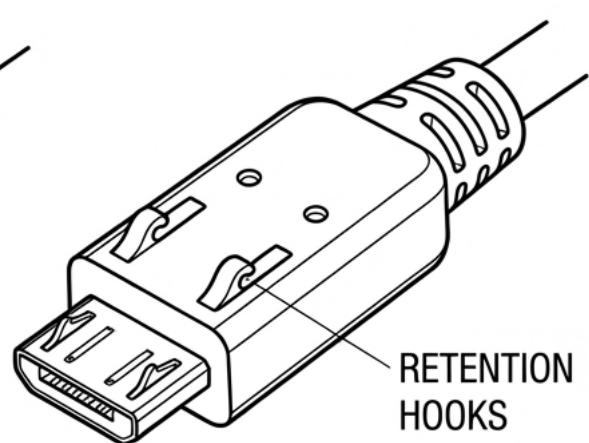
3.3 Mini USB & Micro USB

- **Mini USB** MP3
- **Micro USB** USB 2.0

MINI USB



MICRO USB



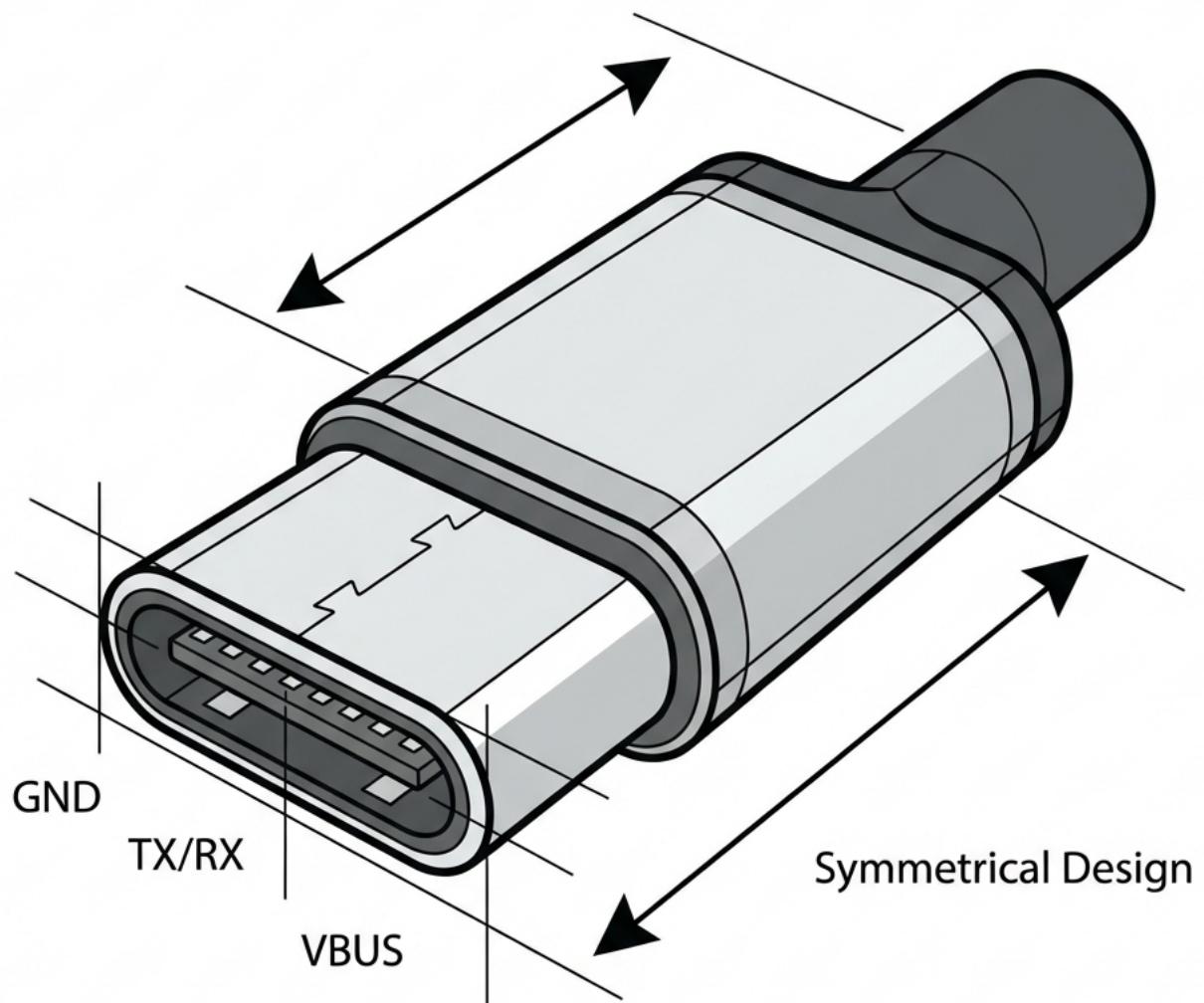
MINI USB

MICRO USB

3.4 USB Type-C

- DP Alt Mode 240W USB PD
- 24 22 CC (Configuration Channel)
- **Type-C** Type-C USB 2.0

4



4. 3 USB (USB Transfer Protocols)

USB USB-IF (USB)

4.1

- **USB 1.0 / 1.1:**
- **Low Speed:** 1.5 Mbps ()
- **Full Speed:** 12 Mbps
- **USB 2.0:**
- **High Speed:** 480 Mbps " "

4.2 USB 3.x

	(2013)	(2019)			
USB 3.0	USB 3.1 Gen 1	USB 3.2 Gen 1	USB 3.0 / 5Gbps	5 Gbps	8b/10b
N/A	USB 3.1 Gen 2	USB 3.2 Gen 2	USB 3.1 / 10Gbps	10 Gbps	128b/132b
N/A	N/A	USB 3.2 Gen 2x2	USB 3.2 / 20Gbps	20 Gbps	128b/132b

USB 3.2 Gen 2x2 Type-C Type-C

4.3 USB4

USB4 Intel Thunderbolt 3

- **USB4 Gen 2x2:** 20 Gbps
- **USB4 Gen 3x2:** 40 Gbps ()
-
- **(Tunneling)** (USB 3.2) (DisplayPort) PCIe
- USB 3.2 USB 2.0 Thunderbolt 3

5. 4 Thunderbolt () (Thunderbolt Technology)

Thunderbolt Intel Apple " " " "

5.1 Thunderbolt 3 (3)

- USB Type-C
- 40 Gbps
- PCIe x4 () DisplayPort (5K/8K) USB
- 3 USB 3.x USB

5.2 Thunderbolt 4 (4)

4 40 Gbps

5.2.1 4 vs 3

1. PCIe	4	PCIe	32 Gbps (3 16 Gbps)	(eGPU)	SSD
2.	4	4K	8K (3 4K)		
3.		Intel VT-d DMA	DMA		
4.	4	(Hub)	1 3 3	(Daisy Chain)	

5.3 Thunderbolt vs USB4

- USB4 3
-
- **USB4** " " 20Gbps 40Gbps PCIe
- **Thunderbolt 4** " " 40Gbps PCIe Intel
- **Thunderbolt 4 USB4** " "

6. 5 (Charging & Power Delivery)

USB 2.5W (5V 0.5A) 240W

6.1

6.1.1 USB BC 1.2 (Battery Charging)

USB BC 1.2 USB-IF 2010

- 7.5W (5V 1.5A)
- D+/D-
-
- **SDP (Standard Downstream Port)** USB 500mA
- **CDP (Charging Downstream Port)** + 1.5A
- **DCP (Dedicated Charging Port)** 1.5A
-

6.2

USB PD **D+/D-** /

6.2.1

Handshake Protocol

1. 5V
 2. D+/D-
 - 3.
 4. /
 - 5.
- [!NOTE] D+/D- USB " "
-

6.2.2 Quick Charge (QC)

Quick Charge Android

QC 1.0 (2013)

- 10W (5V 2A)
-
-

QC 2.0 (2014)

QC 2.0

- 18W
-
- Class A: 5V 9V 12V
- Class B: 5V 9V 12V 20V
- 3A
- D+/D-
- 5V D+ = D- = 0.6V
- 9V D+ = 3.3V, D- = 0.6V
- 12V D+ = 0.6V, D- = 0.6V
- 20V D+ = 3.3V, D- = 3.3V Class B

QC 3.0 (2016)

QC 3.0

- 18W 22W
- 3.6V - 20V
- **200mV** QC 2.0
-
-
- **38%** QC 2.0
-
- QC 2.0

QC 4 / QC 4+ (2017-2018)

QC 4/4+ USB PD

- 28W (QC 4) 100W (QC 4+)
-
- **USB PD 3.0** PD
- **PPS (Programmable Power Supply)**
- **INOV (Intelligent Negotiation for Optimum Voltage)**
- QC USB PD
-

QC 5 (2020)

- **100W+**
- 98%
- USB PD QC

[!IMPORTANT] QC 4

USB PD

QC 4+

PD

iPhone MacBook

6.2.3 OPPO VOOC

OPPO VOOC

VOOC (2014)

- 20W
- / **5V 4A**
-
- QC 5V 4A-5A
- **7 Micro-USB** 5 2
-
- **MCU ()**
-
-
-
-

SuperVOOC (2018)

SuperVOOC

- 50W
- / **10V 5A**
-
- 2000mAh
- 10V 5V
- 5V 10V 5A
-

SuperVOOC 2.0 (2019-2020)

- 65W
- / **10V 6.5A**
- OPPO Find X Reno

125W / 240W (2021-)

OPPO - **125W** 10V 12.5A - **240W** 24V 10A
 [!WARNING] VOOC OPPO Type-C VOOC

6.2.4 FCP / SCP

FCP (Fast Charge Protocol, 2015)

- 18W

- 9V / 12V
- 2A
- D+/D-
-

SCP (SuperCharge Protocol, 2016)

SCP	VOOC					
•						
• SCP 1.0 22.5W (5V 4.5A 4.5V 5A)						
• SCP 2.0 40W (10V 4A)						
• SCP 3.0 66W (11V 6A)						
•						
•						
•						
•						
• FCP						
[!NOTE] FCP SCP	SCP	FCP	FCP	FCP	SCP	

6.2.5 Pump Express (PE / PE+)

Pump Express Plus (PE+, 2015)

- 18-24W
- 5V - 12V
-
- D+/D-
-
-
- QC

Pump Express 3.0 (PE 3.0, 2017)

- 30W
- 3V - 6V
- **USB Type-C** Type-C
- 20 70%

USB PD PE

6.2.6 vivo FlashCharge

vivo " "

(2016)

- 22.5W
- / 9V 2.5A 5V 4.5A
-

FlashCharge 2.0

- 44W 55W 66W 120W 200W
 -
 - vivo
-

6.2.7

(Mi Turbo Charge)

- 18W 27W 33W 67W 120W 210W
 -
 - **QC 3.0**
 - **+ USB PD**
 - QC
-

6.2.8 (mCharge)

- 18W 24W 36W
 - QC
 -
-

6.2.9 AFC (Adaptive Fast Charging)

- 15W 18W
- 9V
- 1.67A (15W) 2A (18W)
- D+/D-
- QC 2.0 9V

[!TIP]

USB PD + PPS AFC

6.3

QC 2.0/3.0	18W		
QC 4+	100W	USB PD	PD
VOOC/SuperVOOC	20-240W		OPPO/OnePlus/realme
FCP	18W	/	
SCP	22.5-66W	/	
PE/PE+	18-24W		MTK
AFC	15-18W		QC

6.4

6.4.1

-
- 5V 1A/2A
-
- QC 2.0/3.0 9V
- QC + FCP

6.4.2

- **VOOC**
-
-

6.4.3 USB PD

[!IMPORTANT] USB PD 3.0 **PPS** Type-C
 - QC 4+ USB PD - PD - PD + PPS - **OPPO/** PD

6.4.4

- 1.
- 2.
3. **USB PD** USB PD
- 4.

6.5 USB PD (Power Delivery)

USB PD USB-IF Type-C

6.5.1

- **PD 2.0 / 3.0:** **100W** (20V 5A)
 - 5V, 9V, 15V, 20V
- **PD 3.1: EPR (Extended Power Range) 240W**
 - 28V, 36V, 48V

6.5.2 PPS (Programmable Power Supply)

PPS PD 3.0	20mV	-	-	"	"	PPS
------------	-------------	---	---	---	---	-----

6.6 (E-Marker)

Type-C

- **3A** C-to-C 60W (20V 3A)
- **5A** **E-Marker** " 5A " 100W (20V 5A)
- **EPR** PD 3.1 240W

7. 6

(FAQ & Common Misconceptions)

7.1 Q: Type-C

A: 1. USB 2.0 E-Marker 3A 65W/100W 2. PD
VOOC 10W 3.

7.2 Q: Type-C

A: Type-C C - **9.9** + USB 2.0 - USB 3.2 (10Gbps) + 4K + 100W - **4** 40Gbps
+ 8K + 240W Logo

7.3 Q: 65W

A: USB PD " " " 9V 2A " 18W PD 5V 1A 5V 2A

7.4 Q:

A: - 5A 4 - USB 3.2